NOYES (I. P.)

A

NEW VIEW

OF THE

WEATHER QUESTION

By ISAAC P. NOYES,

WASHINGTON, D. C.

SURGEON GEN'LS OFFICE
B, 65
LIBRARY.

RE-PRINTED FROM THE

WESTERN REVIEW OF SCIENCE AND INDUSTRY.

JULY AND AUGUST, 1878.

KANSAS CITY, MO.
PRESS OF RAMSEY, MILLETT & HUDSON.

A New View of the Weather Question.

By ISAAC P. NOYES, Washington, D. C.

RE-PRINTED FROM THE

WESTERN REVIEW OF SCIENCE AND INDUSTRY,

JULY, 1878.

The following remarks are respectfully offered in the hope that they may tend to throw some light upon the further solution of the weather problem.

In connection with the facts and comments thereon, theories will be advanced on the basis of the facts as at present known to us, not with the idea that they will be new to the initiated, but rather with the hope that they may better serve the object of the article by drawing attention to this interesting problem, and in a general way reaching some minds that by other means might not be attracted to it.

The weather by many seems to be regarded as among those things that are "past finding out," yet it would seem that as familiar as the knowledge of natural phenomena is now to the world at large, it should no longer remain quite the great mystery that it has necessarily been in the past. The simple trouble in the past, in this department of science, was the want of the proper medium by which to collect the facts. This subject has had very earnest apostles, but what even can the most earnest devotee do when the very material on which he would construct his laws is beyond his reach. After much controversy on this subject and discussion by such men as Halley, Espy, Henry, Butler, Loomis and others, the great want which they labored for and knew to be absolutely necessary, was finally supplied by the United States Signal Bureau, under Gen. A. J. Myer, of the United States Army. Of course such a bureau has its enemies, and steps have at times even been taken to cripple its actions, and perhaps some would cut off all appropriations for it and leave it among the things of the past, but such a

course it is to be hoped will not be seriously thought of by any controlling element, at least so long as the general treasury can be made to meet the modest demands of so happy a combination of science and practibility. Only by such a large and simultaneous collection of daily facts as this office is year by year patiently collecting have we been able to obtain valuable material toward completing the solution of these questions, and our hope for still more and more light upon this important question is in maintaining such a bureau, and that it may be able gradually to extend its influence to more and more new territory whereby it may be able to do better work and obtain more reliable results, and enlighten mankind with the mysteries that preside over the natural phenomena that govern the weather, making them familiar with its workings, whereby they may turn this knowledge to practical account.

STATEMENTS AND COMMENTS.

The first question that seems to present itself in this relation is, "What makes the changes in the weather?" Years ago certain general facts were known about the changes of the weather. Dr. Franklin, it is said, first ascertained that "all storms travel toward the north-east." Though this fact may not be exactly true, it shows that in his time they had some idea of how a storm travels. Then it has also long been known that a storm travels in the "eye of the wind," and that in order to clear away, the wind must come out in a certain quarter; these and many other things were known, yet there was much that could not be known at that age—that must wait for an advanced condition of things to be explained more fully, while such absurd notions that the moon effects the weather by driving away clouds, etc., were also held. This notion about the moon affecting the weather seems to be difficult to eradicate, at least from the minds of the people at large. They claim to know what the weather will be for the month to come by certain signs about the moon, and they believe that the moon has power to drive away or even collect clouds whereby great changes in the weather are brought about. The only possible affect that the moon could have upon the weather would be from its reflected heat from the sun—thereby working in this manner as the sun does, but this heat is so infinitesimal that if it should be concentrated for all night long upon a given locality it would not be able to develop a cloud as big as one's hand.

I. The first source of the weather, as to changes, conditions, etc., is the sun. This, though a common and well-known fact, is simply enumerated with other facts in order that they may here stand, as they act, together.

II. Is the rotation of the earth on its axis.

III. The motion of the earth around the sun.

IV. The parallelism of the earth whereby the light and heat of the sun is made to shine on the earth's surface alternately more on the North pole than on the South pole.

V. These various conditions ever changing their relation to each other have for one of their results what we term the weather.

VI. The text books on natural philosophy tell us that "currents of air, or winds, are produced by the unequal distribution of heat over the earth." The facts gathered by the Signal Service Bureau substantiate the statement; but then very little is gathered from this single statement by which to understand the weather.

VII. When an effect is noticed it is our duty to ascertain the cause. The inquiring mind seeks to get at the most plausible cause. We cannot alter the facts to make them accord with what would seem reasonable to us—we must take them as we find them and build up our theory accordingly.

VIII. Mere meteorological tables taken without relation to one another are of very little account. They form a cumbersome material very awkward to handle. The system now in vogue of daily observations taken, at the same moment of actual time, is far more valuable and reliable as to facilitate the operations of working out the great weather problem.

IX. We should endeavor in this, as in all our labors in behalf of science, to separate whatever is merely accidental or local from that which is general and forms an essential element in the grand laws of the universe.

X. It is the practice of the Signal office to publish three maps a day, but only one, that based upon the observations taken at 7:35 a. m., receives a general circulation. The second and third maps, more specially designated for scientific purposes we presume, are founded upon the observations of afternoon and midnight. More observations the better, for the changes are sometimes so rapid that an observation taken at 7:35 a. m. would give no idea of the actual condition of the weather for the best part of the day.

XI. Some localities are dry and some wet. In some, changes from one condition to the other are rapidly taking place, while in others one condition or the other is more or less protracted. The question is, Why is this so? It would not seem that any one thing was the cause. Nature obeys the strongest force. We see this in all things. The strongest, however, is more or less influenced; it however predominates; yet not without more or less compromise.

XII. The wind from the South, it is obvious, must be warm, while that from the North is cold. As a wind partakes of these elements it will be either warm or cold. Yet at times there are apparent exceptions to this. Sometimes in the winter we have quite a cold southerly wind, but this it will be found to be because what is to us locally a southerly wind is generally an easterly or westerly wind partaking more or less of northern influences.

XIII. All winds from all quarters, that is, all kinds as to force and moisture. The quarter itself not the governing influence only as to cold or heat; for example, more especially in the Atlantic States an easterly wind is dreaded, and thought to bring peculiarly disagreeable stormy weather, yet it does not always, and apparently it is the merest accident when it does. Some of the finest weather we have in this country we have with an east wind, and that, too, without resulting in a storm.

XIV. It is sometimes locally hotter at the North than at the South, because

it is *generally* hotter at the South. This may seem paradoxical, yet it is plainly evident from the facts that bear upon the subject depending on the condition and location of the low barometer center.

XV. In this matter of the weather we need to give our attention to all the laws respecting it, but more particularly to *observe the general rather than the mere local forces*, for the general force will prevail over the local—swallow it up as it were—sweep it along with the tide.

XVI. Change in weather. The great factor that makes the change in the weather is what is termed "low barometer." The great source of which is evidently the variable concentration of the sun's heat upon certain portions of the earth's surface. This fact has long been held, and like many other points in natural phenomena has been controverted and ridiculed, but the later observations by the United States Signal office seem to verify it and place it beyond dispute.

XVII. It is an undisputed fact that there are certain localities where the barometer is much lower than at others;

XVIII. And that the winds from all quarters move toward the centre of *low*.

XIX. Though the winds are in the direction of *low* they do not at all times blow with equal force toward this center. Sometimes it blows the hardest from one direction and sometimes from another, depending upon local conditions.

XX. In opposition to *low barometer* is *high barometer*. So on the weather maps will always be indicated these two extremes.

XXI. There are a great many of these centers of high and low barometer.

XXII. There are large and small centers of high and low barometer.

XXIII. These centers are ever changing.

XXIV. *Low* travels from West to East and generally on a line somewhat North of East, as will be seen by a daily observation of the weather maps. At least this is true as to land. What it is on the ocean we do not as yet know, though there is some evidence that under certain conditions the direction is reversed. We have few facts to prove either that it does or does not, and what little authority there is on the subject would seem to convey the idea that there was no difference in this respect from the land and the sea. Yet if one will follow up the course of *Low* as presented on the weather maps this would not seem unreasonable to believe. We trace a low along the land till it enters the ocean. Then if we will bear (XXV) in mind the fact, that other things being equal (and the *other things* are local forces) the wind will travel in a straight line from *High* toward *Low*. This is both natural and in accordance with the facts of the weather maps, though it has been stated by some that such is not quite the case, rather that the wind is between the two, that is if you stand with your left hand toward *high* and your right hand toward *low* the wind will be directly in your face. The natural forces and the facts of the weather map will not warrant any such a supposed law. The undoubted law is that the wind from all quarters will take the most direct course possible toward the vacuum *low*, and it seems obvious that the wind will take a more direct course on the ocean than on the land, for

here it is all one element—water—consequently there will be less of local forces to detract it. This being the case, even though we know not exactly where *low* is, we can by noting the direction of the wind tell in which direction it is and trace its course.

XXVI. Now in the United States *low* disappears off of the coast, generally, though not always, up in the north-east. By some it is said to be lost in the sea. The wind then begins to blow to the west—north-west—north—then finally around to the north-east. About this time a new *low* sets in down off Florida. In no particular locality, but in this general neighborhood, and at times the movements of *low* are so regular as to present itself in the neighborhood of some one locality on a certain day for weeks, varying in its course but leaving its tracks in part at least over the same ground.

XXVII. This being the case it would seem that low barometer under certain conditions obeyed the other great laws of nature, of the course of our earth around the sun and the planets and comets in general, and that when in *connection with land and water* as on the east coast of the United States (and perhaps on the west coast of continents also) it travels in ellipses; *i. e.* on land generally traveling from west to east and perhaps the same on the sea, but in the immediate vicinity of land and sea from east to west.

XXVIII. Of course we have not the facts to prove this, and it seems contrary to the general fact that *low* travels, at least on land where we can trace it from day to day, toward the east, or the sun, yet the course of the wind along the east coast of the United States, as traced above, would seem to carry with it some weight that *low* somehow or other was differently influenced by the joint action of land and sea to what it was when directly on one element. We know not the facts in the case; we can only infer this—attempt to interpret the unknown by the known. It may be many years before it can be actually proved; yet as an aid toward solving it, it would seem well to have some staunch, swift and able steam vessel to endeavor to prove it by being in readiness up in the north-east when *low* was just moving off the coast, and follow the center of the storm as close as possible. Judgment should not be based on simply one experiment, but it should be followed up a number of times, and even by a number of vessels, that we might have as much information on the subject as it would be possible to obtain.

XXIX. We cannot at present make ourselves familiar with all the changes of low barometer. We have no information from a greater portion of the land surface and can at present have nothing from fixed localities at regular stated intervals from the vast expanse of water, that make up the greater portion of the globe. At some future day, however, we may be able to establish mid-ocean stations,* when we can greatly further our studies of this beautiful system whereby our earth is made habitable. We, however, do already understand enough to see the passing wisdom in having this constant shifting of the areas of low and high barometer, whereby blessing in the form of grateful showers and fruitful sunshine is made continually to visit different portions of the earth's surface—

*A plan for this was suggested by the writer in a paper published April, 1876.

* This was written in 1878 — When we had little "light" on the subject — Later evidence (facts) prove the general course of "Low" to be towards the East
W. Ferrel.

making it more habitable for man—generating the "clouds that drop fatness," and following this up with freshness of air and sufficiency of heat to propagate and maintain life.

XXX. The "first cause" in this department, putting aside heat, etc., is low barometer. Whether we have all the information on this particular point that we can ever ascertain we know not, but one thing we do know, that the lightness of the air at *low* is a fact, and that where *low* is there will be the storm center, and when this passes away and the barometer indicates *high* we will see the sun shine and we shall have what is understood to be pleasant weather again.

XXXI. What makes the conditions we term *low* is not so easy to comprehend. With our present knowledge it would seem more reasonable to us to have low barometer in the vicinity of the warmest places, but (XXXII) a low barometer does not go with a high thermometer, at least so far as we can detect. We have low barometer in regions of perpetual ice. Though at present we cannot comprehend why this should be we can see a passing wisdom in having it such.

XXXIII. The movements of low barometer are much the same in winter as in summer, that is in summer we have northerly winds and in winter southerly winds; though in the winter we have a prevalence of northerly winds and in the summer a prevalance of southerly winds, showing that as the wind is always toward the low barometer that the conditions of low barometer are generally in a higher latitude in the summer than in the winter (*i. e.* north of equator and the reverse south) though these conditions are not confined to localities of latitude.

XXXIV. A theory as to *low*. First, *low* as marked on the weather maps and as generally understood is only relatively low, and so with *high*. A *low* may sometimes be really higher than *high* sometimes is, and the reverse. Then these change as to latitude. Generally throughout the United States 30.30 inches high, and 28.30 very low.

The sun shines on the earth. We may call high or low barometer normal, it matters little so long as we take some definite starting point. In this paper let the whole area of the United States be represented as *high*. In this condition we will have bright sunshine and clear sky. If the earth were one vast plain, and the sun a fixed point of heat, and no water present or near, we should continue to have a sameness of weather for month after month and year after year. But the surface of the United States is not, nor is any portion of the globe generally made up on this basis. There are, however, local spots on the earth's surface answering partially to these conditions but not wholly. The mere condition of the earth's surface in certain localities in flat-plain-like without certain factors to cause, or with certain factors that prevent change, but the sun does not remain stationary, so even though the earth's surface be favorable for a normal condition in itself, the constant changing of the sun's heat and its regular periodical withdrawal would necessarily make changes from time to time. The earth's surface fortunately is irregular and interspersed with much water in addition to the great oceans. The sun must shine over the eastern portion first. The surface of the earth at this point will begin to be heated; this will expand the air immediately

above it causing it to ascend; cooler air will rush in to fill up the vacuum, or perhaps better to prevent it. From the time the sun is relatively to a given spot 45° high in the east to 45° in the west, the greatest heat of the day will be concentrated on that spot. In addition to this the heat of the sun will gradually begin to evaporate the water and form clouds. These obeying the natural law of their peculiar construction will float in the air; showing that they are in this state balloon-like and lighter as a mass than what we call air, even though they have apparently a far more materialistic form. A current of wind is gradually established toward the most heated portion. Clouds are not only being developed here but all over along the path of the sun. The sun will move along on its course, the earth will retain its heat; the water present will have a propensity as it forms in clouds to cool. Perhaps the first day will not make any great change, but after a few days some one point or circuit, say of a hundred miles, becomes established, from the attraction of peculiar local forces and other causes, whereby this air is heated and becomes lighter than its surroundings. Though night comes on and cools the air, the whole of the earth is subject to the influence of night, making the different portions of the earth relative in this respect. So when the sun rises on a new day he as it were takes hold of the near or eastern end of the track where he left off the preceding day. His rays are naturally concentrated where it is the warmest, yet beyond any area of heavy clouds. Of course as there is an effort on the part of the sun to heat there is on the other part of nature a disposition to cool. Clouds are the while developing and even becoming attractive and condensed in themselves, etc.

The process advances till a quantity of clouds or suspended moisture is formed; the more the moisture the heavier the clouds, From all points currents of air set in whereby these clouds are gathered together. This gathering together of clouds and wind produces a number of effects. The winds are from all quarters and therefore of all degrees of temperature, but on the whole the tendency from this is to cool the atmosphere. The presence of the clouds is another tendency to cool even though they become a mantle over the earth for retaining heat. So these facts if nothing more would cause the locality called *low* to be reduced in temperature. The clouds are full of rain and they will precipitate. The sun the while has moved along to another point, where there are less clouds, heating that and going through with the same process say at an interval of five hundred or a thousand miles, more or less, depending on locations causing an attraction of wind and clouds to that spot. The next day the sun rising in the East it will more or less heat spaces to the east of these localities, and perhaps a little north of south, thereby causing, as it were, the centers of *low* to move to the eastward—at least for land. Perhaps, so far as we know at present, the centers of *low* may encircle the earth though there is some evidence (as referred to above) of the sun heating portions more and more to the south of east and gradually working to the south—south-west—west—north and north-east and so around in a circle or circular course—at times larger or smaller. These points as

to the course of *low* at present, however, are not facts; this is only to suggest an account of certain facts seeming to favor it, but whether *low* travels thus or directly across the ocean as on land can only be ascertained by further and careful observation. *Low* is continually on the march generally toward the east, unless there be local exceptions, this much is an admitted fact.

It is said that "a vessel bound to the westward meets *advancing* areas of low pressure, and the observer finds that his barometer falls and rises again more rapidly than it would were he on shore, while an observer on board of a ship bound to the eastward has just the reverse experience."—(Circular Signal office 1878). This if anything would seem to show that water heats and cools more readily than the land and that the sharpest grades of temperature would be on the east of the side the sun approaches the center of *low*. So from the barometer an expert could tell, if he had no other means, the general course of the vessel—eastward or westward. Yet at the same time this does not necessarily prove that *low* does not travel in ellipses. This, however, would seem to suggest that the navigator, especially the officers of the ocean steamers, be requested to note the course of the wind in connection with the low barometer centers; by a careful note of this fact we might be able to determine something quite reliable as to the probable course of low barometer centers.

XXXV. The center of *low* is not the warmest point for various reasons. The generation and concentration of moisture tends to cool, to say nothing of the winds coming in from all quarters north as well as south. This being the case, it has been a subject of warm discussion on the part of some writers on the subject of the weather, Mr. T. M. Butler, for example, (in his "Atmospheric System," 1870) for this and for other reasons contended that the conditions we term *low* could not be thus caused. His idea was ~~not~~ that if *low* was caused by the concentration of the sun's rays on a given point that we would have *low* at places where there is the greatest heat. According to human ideas it certainly would seem that such should be the case, but it is also a law of nature that (XXXVI) the conditions of low barometer is not, at least often, associated with a desert or very dry places, and not at very hot places at the expense of cold places. Other things being equal, *low* will predominate where there is the most water, or at least where there is the most admixture of water, and the reason seems obvious. When there is no moisture, sure, the ground heats up quick, but there is no material for clouds there. The sun is all the while passing on, night comes ~~on~~, and what was so hot during the day becomes very cool at night. Had there been clouds to center there the heat would have been retained; no heat is retained as a basis for the work of developing a *low* the next day. The process of heating has to be all gone over again. Evidently the best combination for retaining heat is a good interspersing of land and water.

XXXVII. Other things being equal, the *lows* would probably be permanent at the equator, but they are not, and as we become more and more familiar with the facts of the weather the more and more we see the wisdom of the Creator in having the various combinations of heat, the distribution of land and water, the

inclination of the axis of the earth, etc., whereby the weather is equalized, tempered and changed.

XXXVIII. Mr. Butler, after discussing the question of *low* and saying what it was not, put himself on record ("Atmospheric System," page 381) that it was caused by "electricity." Such a man as he we know would not deal with such a thing lightly and say "electricity" in any wiseacre sense. It is not pleasant to controvert one much older in the service than yourself. Perhaps it is electricity, but Mr. Butler did not sufficiently explain his point, and now, for this world at least, he is beyond the power of the discussion of a topic in which he took such an absorbing interest. On this point, however, I would venture the suggestion that electricity itself may, after all, be nothing more or less than heat. Without heat there never could have been electricity; it seems to be only a higher or more subtile form of heat, as it were, bearing about the same relation to heat in general as ozone to oxygen.

XXXIX. Again Mr. Butler maintained that if there was what is now commonly called a "hole in the sky," that clouds must necessarily shoot up through this hole, and he offers quite a reward to any one who ever saw such a sight as a cloud—a scud—going heavenward This he seemed to think conclusive evidence against the theory that *low* is formed in the manner here referred to. The air may go up without taking a cloud. A cloud is only a mass of water combined with air—balloon-like. When a maximum point of moisture is reached the water re-falls to the earth. At a center of *low*, clouds are piling in towards each other; as they are thus brought together they are compressed in proportion to the force of the currents that brought them together and, as it were, the water is squeezed out of them as though they were so many sponges. Where is the air that also helped form them? It is not unreasonable to suppose that it rises towards the heat that is on the upper side of the clouds. So it does not seem inconsistent to believe the common and generally-acknowledged theory on this point—and it would seem very strange to see a heavy rain-cloud take an upward flight—especially when we know that beyond a certain limit the air becomes very rare and incapable of sustaining bodies of any great weight.

XL. It is a fact, however, that the lighter cirrus clouds are often seen moving above the lower and heavier clouds, and in an opposite way from the way the wind is blowing on the surface of the earth. This fact, if it proves anything, would seem to go to prove the "hole in the sky" theory, by showing that there are upper currents, as is also ascertained by balloons moving in another direction from the surface currents. This will readily fit the theory that the air does ascend over the spots called *low* and that the air is seeking to equalize the various forces whereby it exists.

XLI. This is, as it were, Nature's grand plan of ventilation and purification, whereby we have a bountiful supply of fresh air far beyond the demand.

XLII. *Low* travels eastward, at least as a general rule, or towards the sun. Did the sun rise in the west this would undoubtedly be reversed, and we should see storms traveling (generally) from the East towards the West.

XLIII. There is a common saying that a storm travels in the "eye of the wind," i. e., in the direction that the wind is blowing. This is true in some cases, but it must be seen that it cannot approach to the dignity of a universal law—it depends much upon the locality, and particularly upon the relative location of *low*. Along the Atlantic coast this is more true of a North-east storm than any other. There are cases where this for some localities may be true with a North-west wind, when a *low* starts in on the coast and takes a North-west direction. Such a storm center or *low*, however, bends to the East, and apparently sgoe to prove that *low* travels in circles or ellipses. Familiarity with the motion of *low* and the fact that its *general* course is towards the East, will make it a very easy matter to trace a storm and make us more skillful at forecasting the weather.

XLIV. On the maps the changes are marked *high* and *low*. *High* it would seem, according to the principles here treated upon, should follow *low*, and such appears to be the fact, although it would not seem to rank with *low* as an independent condition, but rather as an adjunct. We could have no *high* without a *low;* the *low* is the governing condition.

XLV. Can we ever have *low* under our control? It would seem not, yet we evidently can help in establishing centers for *low*, as in deserts, where there are naturally none, by planting trees and inducing foliage to develop, whereby moisture may be drawn up from the earth and what may be present in the atmosphere retained, thereby heat prevented from escaping through the night, etc.

XLVI. Where there is foliage the conditions *low* are more equally and extensively developed, and this leads to (XLVII) the conditions of storms that follow woodless countries. Where the woods are cut away we have great droughts and sudden and fierce winds and rains. As to rain, much depends on the extent of the area of barren soil. In all these changes many influences are at work, and we cannot make ourselves too familiar with the idea that the strongest factor is going to prevail.

XLVIII. When a storm is working up more or less moisture is developed according to the circumstances herein spoken of. If clouds are spread over a large extent of territory and *low* is not very concentrated the precipitation will be light. It is then that rain "comes down like mercy," and does so much good, as it has plenty of time to penetrate the earth, and therein lay up a supply against the seasons of drought. As foliage tends to accomplish this and regulate and equalize it, as it were, it would seem worth our while to heed it. The fact itself is known, yet many facts that we really well know are not fully appreciated until stern necessity presents them to the world in the most forcible manner and in the most powerful light.

XLIX. As has been remarked one *low* follows another at shorter or longer intervals. Again a condition of low may circumvent a place or locality, and then at times one place or locality will have an abundance of rain—rain almost every day for perhaps two weeks, while another will not the while have any; as it were one locality has rain at the expense of another. (See plate).

A *low* may start in on the coast of L and take a regular course toward the

north-east; it may start in at G, take a more or less circular course, and thereby pass locality K, or start in H or I and travel to the northwest, leaving the Atlantic States without rain; or it may, separately or in conjunction with others, start at E, F or D and take a more or less direct easterly course to the Atlantic ocean. These lines illustrate the general course of *low*, but if the engraver should exercise his imagination to the utmost and make the lines so thick and intricate that they could not be deciphered, or lose their identity in multiplicity of directions, he could not give all the changes that are constantly occurring in the paths of *low*. One of the missions of the Signal Bureau will be to note the course of these *lows* and to see how they are associated with any particular season of the year.

L. In nature nothing is more marked than is this matter of rainfall that the strongest factor will prevail. Other things being equal the rainfall will be at *low*, but they are not, so we occasionally have an apparent exception to the fact that low barometer is the cause of rain. On the 10th of April, 1878, *low* was off in the north-west and extended over a large territory. The wind, as was natural,

set in to the eastward, and under such conditions it does not move with the rapidity it does when *low* is concentrated, so under these circumstances the clouds were carried along very slowly. They were the while, however, growing heavier and being wafted toward *low*, but coming in contact with a changed condition of atmosphere on the border lines of *high* and *low*, precipitation took place, prematurely as it were, so that there was little or no moisture to precipitate when the real center of *low* was reached. The strongest factor in this case was the coming in contact with a changed condition of atmosphere. This does not often occur and it would seem could only occur at such times as when such conditions have referred to meet. Yet this would prove, if anything, that clouds were being developed all over—more or less according to circumstances of moisture, heat, etc., and that the condition *low* was simply a means of concentrating moisture over a given district. Such a condition as this may be difficult to prognosticate. It would be, apparently, the most natural to expect the rainfall at *low*. This, however, is a fair illustration of one of the many things with which the Signal office has to contend, at least at present; perhaps at some future time when the officers become more familiar with the workings of nature they may know better how to calculate upon the neutralizing influences of what may become under some circumstances, for the time being, the *strongest factor*.

LI. The United States is a fine field to study this subject, and it seems to be divided into three distinct systems: that east of the Rocky Mountains, A; that ~~embracing~~ between the Rocky Mountains and the Pacific coast range on the west, B; the narrow strip ~~embracing~~ betweeen the Pacific Ocean and the coast range on the east, C. Could we have the same complete system throughout the world as we have here we could undoubtedly gain still more valuable information as to the working of the weather system. The natural laws are evidently the same though they may not in all parts be in the same balance as here. On the basis of the strongest power prevailing, there may be certain apparent variations which may appear to conflict, when in reality they all follow the same general law.

LII. The best portion of the United States for regular conditions to follow each other seems to be east of the Rocky Mountains. It has sometimes been said that our storms come from the Rocky Mountains, but from the weather maps and the natural laws that *low* appears to follow, it would seem that they do not generate anywhere in particular, and are liable to generate at any portion of the Earth's surface; indeed, there is a constant struggle at every point—the strongest force prevails and a small *low* is sometimes, as it were, swallowed up by a larger one and borne on by it, or at times to even develope within a very extended one.

LIII. There are general and local laws, and this accounts for places near each other having currents of wind in even opposite directions, and for the fact while the general wind is in one direction, a local wind may be in another and even just the reverse. In such cases, however, the wind will not generally be very heavy.

LIV. "Polar Waves."—This is a nice expression, yet strictly speaking there

is no such thing; the laws that govern the system do not warrant the use of it, at least otherwise than in a figurative sense, for to the north of us there is evidently another line or lines, as it were, of *lows*, running in all directions as generally in the territory of the United States; and to the north of what is here called a "polar wave," there are undoubtedly warmer circles at the time than in the current of this "wave" that is supposed to be, or, as its name implies, is all the way from the icy North, for the reason of there being another center of *low* away up there, whereby in that north latitude local south winds are generated. We learn from Arctic voyagers that the wind up North at times blows from the South, as well as at other places on the Earth's surface; perhaps not as much, yet it does so blow, and this will reasonably account for it and is evidently the reason for it. At the North they might as well have the expression, "an equatorial wave," and it would be just as proper as to say a "polar wave," at least in this sense.

LV. The condition *low* is, as has been remarked, the controlling power—where *low* is there will the wind be concentrated—toward these centers the currents will be established. When (North of the Equator) a North wind blows, it will necessarily be cold, unless, perhaps, as in cases where the *low* is not very positive, and the wind is light and must travel over extended plains, as occasionally in summer, as herein referred to. This, though, is only an illustration of the predominance of the stronger factor. And when a North wind blows it will be on account of a low barometer area at some point South, and not, as is sometimes thought, because of a condition of high barometer up North. A condition of *high* does not push on a current but a condition of *low* pulls along the current; **in other words, wind is pulled, not pushed.**

LVI. The territory in the United States embraced between that portion of the Rocky Mountains running N. W. and S. E. and S. W. and N. E., Salt Lake City being its eastern angle, and the "Blue mountains" running N. E. and S. W., and the Sierra Nevada mountains to the S. E. and N. W. (see plate B), which has an elevation of from 4,000 to 5,000 feet, seems to have, as it may be termed, a "condition" by itself and to have its own local *lows*, as it were, cut off by the mountains. There are, however, few stations in this locality, so the world is not at present fully informed of its changes; yet, from the observations taken at its four quarters—Salt Lake City, Boise City, Pioche and Humboldt City—the conditions *low* seem to be local. The strip of territory between the mountain range and the coast has quite a different climate from the rest of the United States. California has a peculiar weather condition. If these mountains are the cause of this, it may be asked, why does not the Blue Ridge and the Eastern ranges of mountains affect the Eastern climate? They undoubtedly do, but not in this manner, for *low* seems to travel without much regard to them. They are lower, less extensive (horizontally) and are, as it were, set in the midst of fields, whereby their influence for chilling the air is counterbalanced. On the Pacific slope, however, we have a high and extensive range of mountains that cools the air, thus affording a check to the further development of *low* across them. But for these high and mountainous regions, *low* would undoubtedly

travel directly across the land, start in at the Pacific shore and travel regularly—depending on the force of the heat and neutralizing influences—with more or less rapidity toward the Atlantic coast. But the coast range, backed by the high plateau country as far West as to include the Rocky Mountains, makes quite a different condition of climate for this territory from what it would be if it were comparatively level. To illustrate, say *low* is developed on the land; it is checked in its course eastward by the coldness of the mountain airs and is, as it were, shut off from the East. So, in a similar manner, the *low* that is developed in what may be termed the mountain quadrilateral, but with the territory to the East of the Rocky Mountain range it is altogether different. Here *low* has a broad and comparatively uninterrupted field through which it travels as it wills, or as the Sun will dictate, sometimes starting here and sometimes there. (See plate.)

LVII. The higher the Sun works up, *generally*, the higher the line of *low*, and the reverse; and the more concentrated and positive the *low* will be in these upper or lower latitudes. (Reference is now had to North latitude.) So we see that the North winds prevail in the winter and the South winds in the summer. This a general law and not a special one, that necessarily follows the Sun in its course North and South of the Equator. We do, however, have centers of *low* running quite high during the winter, and this causes South winds and warm weather; when the reverse and *low* is low, we have severe cold winters. Because in the United States or in any parallel of latitude they have a warm winter or cool summer, it does not imply that the weather to the North of this line will be correspondingly affected; it may or may not; may be correspondingly colder or warmer, all depending on the line of *lows* in these regions, which may be quite independent of those to the South of them.

LVIII. As to cold winters and warm winters, it seems a matter of mere accident, so far as we know, yet of course beyond us there may be a Providence in the matter that has special reasons for such a condition of things, but so far as our knowledge reaches it appears to be the merest accident, as the location of *low* itself. *Low* starts at a certain point; it must continually seek new fields; and it is a wise law that it should, even though it may sometimes come around to locations that cause weather that to us appears out of season. This being the case, it seems very plausible to me that it must be irregular in its time and place, and that it is liable to be constantly overlapping itself, so that after a number of years it gets around to certain localities, causing atmospheric conditions that would not seem natural for a given locality, being cold when our months should say warm, and warm when they should say cold. But nature is nature, and it seems in accordance with herself to have her continually, as it were, overtaking herself. She is all the while obeying the strongest force, either positively or negatively. If our seasons in the course of periods change so as not to accord with the present names of the months, it will be in accordance with this principle—and it may account for many changes in the past history of our Earth that cannot otherwise be accounted for. The greater or less amount of water present

has much to do with this matter of climate. We know that there is evidence in past ages of the world, of some northern localities, at least, being much warmer than at present. We also know that eruptions have occurred, and that whole tracts of country have been raised above the surface of the water. As the effect of the sun's rays on the water is peculiar and different from their effect on the land, may there not have been conditions that have made localities relatively different from what they are now. This idea of Nature, as it were, gaining on herself, even though slowly, may also give the color of reason to the idea that the earth is gradually changing—that no one point is permanently relatively fixed with any outside body—and may not the same idea extend to the whole universe? It would not seem unnatural; what may account for a small thing may also account for a large one. All nature works on a similar plan and after the same general laws.

LIX. Low barometer centers in the ocean. The chances are that *low* is distributed over the ocean in a similar manner as on the land. The fact that vessels at sea have the wind from all quarters, meeting with storm centers and calms, and have the wind to shift from one point to another, would evidently, beyond doubt, go to prove that such is the case. This, however, would go to disprove the poetical idea that the waves beating on any given point, say on the rocky shores of New England when the wind in to the eastward, are all the way from the shores of the Eastern continent. It is very improbable that they are ever from such a distance. The chances are that there are a number of low barometer centres between the two continents, and that the wind that raises the seas that strike against the New England shores, starts not more than from two hundred to five hundred miles away, and perhaps not always at as great a distance. The force of the ocean wave is not altogether in the distance that it has to travel, though it does require quite a distance in which to raise a heavy sea; the force of it, however, must depend upon the force of the wind, which in turn depends upon the power of *low*.

LX. Clouds.—In the Signal office at Washington there is a large case in which the weather of the earth is illustrated in miniature. The clouds are formed of cotton and are nicely and artistically executed: the different kinds are true to nature, from the most delicate clouds that are first formed, to the heavy black clouds that produce the heaviest rains. The whole case is a wonder of handiwork, wherein the whole meteorology of the earth may, to the initiated at least, be seen at a glance. It is not the purpose of this article to more than refer to this; it would seem, though, that every college in the land, and every high-school, should have such a model, as by it this subject of the weather can be studied with great advantage. Certain conventional names have been given to the different kinds of clouds. Of course there are all kinds, from the very light to the very heavy, and these can be seen merging into one another without any respect as to the name they bear. However, it is well to know them by the established names, for thereby we not only have the pleasure of knowing them

better, but we can the better describe them and gather information in regard to the weather by their form and combination, etc.

LXI. WINDS.—The winds are governed by the condition *low*, and therefore the governing condition has been spoken of first; yet the two are inseparable, and are only here apparently separated because language will not allow us to speak of two things at once.

LXII. The force of the wind depends upon the power of *low*.

LXIII. The direction of the wind will generally be toward *low*: it may be deflected by local forces, for the local is ever contending against the general, and the reverse. This has been referred to under the head of *low*. The harder the wind the more direct it will blow toward the center. It has been said that if we will stand with our left hands toward the region of *high*, and our right toward the region of *low*, that the wind will be in our faces; but the weather maps do not seem to warrant this as a general fact, though when there is a very large circle of *low*, and therefore not concentrated, such at times may locally appear to be the case. If there is anything in the idea of the conditions of low as herein spoken of, it would seem natural that the currents of air should generally be in towards the centre *low*. The daily weather maps seem to warrant the assertion and to be in full harmony with it.

LXIV. As to the force of the wind, it all depends upon the rapidity with which it is moving, and the rapidity depends upon the positiveness of the condition known as *low*. It is, however, subject to natural forces in a similar manner to more materialistic things, water for example.

LXV. It will be more or less retarded by friction, and over the sea there will be less friction than over the land and less over level tracts than over uneven and mountainous districts.

LXVI. As the wind will travel in as straight a line as possible, we can oftentimes, by observation as to the direction of the wind, trace the course of *low*, and form an approximate idea as to its probable locality. Occasionally there is an apparent exception as to the course of the wind towards *low*: for example, we sometimes have quite a cold south wind. This, however, will be found to be only local, and that such a south wind is in reality a west wind, with simply a changed direction for a comparatively short distance—changed by some local condition, such as a struggle to develope a sub or local *low*, or occasioned by some natural lay of land, such as the presence of a body of water, a mountain range, etc. An illustration of this effect may often be noticed in a city; though the wind may be blowing from the northwest, it may eddy or be deflected around some corner and blow (locally) from the southwest or even south. Because in this confined locality the wind was from the south, it would not be right to say that it was a south wind.

LXVII. Old people often speak of the wind going around from one quarter to another "with the sun." Such observations are oftentimes made and transmitted from generation to generation, yet without reason. People see that a storm comes, passes and clears off in a certain manner, but it was not until

within a very few years that we could trace a storm over such a vast area as the United States. Now we see why the wind should come up in a certain manner and pass around to another quarter, and so on till it comes out finally with the wind from another direction, and clears off; and why the wind is ever going from one point of the compass to another, and why a storm is liable to come up with one wind as well as with another.

LXVIII. It is a common thing to hear that "the wind is blowing up a storm." It may seem contrary to the wisdom of the past to deny that the "wind blows up a storm," yet from the remarks on the condition, *low*, it must seem obvious that the wind does not blow up a storm, but rather that, if anything, the reverse of this is more true, that the storm raises the wind. A *low* is developed, the wind rushes in to fill the vacuum. If *low* is, say in the middle of the United States, to the west of the same, the wind will be from the west; while to the east of the condition, the wind will be generally from the east: and if it passes to the south of a certain point, the wind at that point would be from the north, and the reverse if to the north. So the manner in which the vane turns will depend upon the relative location of the center of the condition *low*, toward which the wind will always blow. This can be better traced by reference to the map or plate.

LXIX. Then an east wind is generally considered a very stormy one with us, yet it is purely accidental, and we sometimes have exceedingly pleasant and clear weather with an easterly wind, for the simple reason that *low* is traveling to the west of our particular locality, and may pass us by altogether without producing a storm in our immediate locality. The greater part of the time, however, an east wind is caused by *low* being in the line of our locality, then the clouds that have been generating for days over the Atlantic ocean are brought to us and we have rain in abundance, and all the effects derived from the condition of low barometer. Yet in this connection it must be remembered that what may be a northeast storm in one locality, will to another locality, on some other side of *low* be called a storm from another quarter, i. e., a condition *low* is circular, and the storm converges toward it from every direction. This center may not be an exact circle or even approximate thereto, for oftentimes its real outline is anything but circular. The term circular is here used only in a general sense.

LXX. When there is a very positive *low*, a fierce wind is developed, and as the sun first strikes the east, the storm will travel generally in that direction, and as the wind will be from all directions toward this center, an elastic medium of air is established, as it were, as a cushion for the wind from each quarter to receive and be received upon, whereby the force of tornadoes are checked; otherwise they would do far more damage than they do.

LXXI. Much has been said about equinoctial storms. People have an idea that when the sun "crosses the line," that there must be some extra commotion whereby a great storm is generated. In regard to this, I will venture the assertion that there is no such thing as an "equinoctial storm." Any storm that occurs within two weeks, before or after, is commonly given this name; because

such a storm happens, and is always liable to happen, somewhere about this time, it is no sign that the "equinox" has anything to do with it. Storms are liable to generate at all times, one may occur at this particular time, and that, too, in merely certain localities, when it is perfectly fair at others. This being the case it seems absurd to thus connect it with the sun passing over a certain imaginary line.

LXXII. Rain and snow are essentially the same. This need not be told the initiated, yet there are people who think that the Signal officer has made an error when it is said that "it will probably rain," and it snows instead. It is a mere difference between a few degrees of temperature, and perhaps local temperature at that; if warm it will rain, if cold it will snow.

LXXIII. It is sometimes remarked, that it *feels* like rain or snow, but that it is too cold. In this case the clouds that contain this moisture are present, but if warmer a little beyond, they will pass along to that warmer spot. The strongest force, whether it be heat, cold, or wind, will predominate; the merely local must (generally) give way for the general or extended conditions.

LXXIV. When *low* extends over a large territory, or we are in the center of a concentrated one, the rain will come down straight or nearly so; but when the center of *low* is to one side and a fierce wind is rushing in toward it, carrying heavy clouds along, the rain will come down at an angle; the more fierce the more obtuse the angle at which the rain will fall, and sometimes the wind is so powerful as to make it come down almost horizontal.

LXXV. Trade winds and hurricanes we have not much to do with in this latitude and longitude, yet they, with other conditions, must obey the general law of air seeking an equilibrium. It would seem from what we know of the laws of storms in general, that the "trades" should, as they do, prevail in the latitudes nearest the equator, and that hurricanes should predominate in the same localities.

LXXVI. The manner in which a fierce wind travels has been much commented upon. It is said that it travels, as it were, in epicycles—going comparatively straight or in an elongated curve for quite a distance, then taking a sudden turn in the shape of a small circle, as is sometimes the case with dust in the street. This, however, does not accord with the *general* law, though the air, like the heavier material water, is evidently turned in this manner by local inertia. The more fierce the wind the more compact and the more it is liable to be deflected or swept around in a circle, the same as water, by any resistance that it may meet with. Its inertia of speed forces it on—the inertia of fixed objects, even though small, must cause some compromise—must be overcome.

LXXVII. Tornadoes look black, and oftentimes much resemble a huge serpent rushing over the ground. It would seem to be comparatively easy to account for this. The fiercer the wind the more condensed, and as it moves over the earth at the rate of a hundred miles or so an hour, it will necessarily take up with it much loose earth, dust, etc., whereby darkness of color is given to the whole mass. Then as to its serpentine form, the very compactness will

account for that. The more compact, the more it holds together and becomes a thing of life, having elasticity whereby it may be deflected by one object to such an extent as to pass entirely over or by another object beyond, either horizontally or perpendicularly; thus, up or down, to right or left, it sweeps along on its course, taking as straight a line as possible, yet even in its most fierce condition being obliged to compromise its course more or less, bearing evidence to the law that the strongest force must prevail and showing that some mere local inertia is strong enough to deflect it from the straight line in which it seeks to travel. It is said, sometimes, to rain all sorts of things—sticks, stones, frogs, etc. A tornado, moving at such a fierce rate, is liable to take up and carry along with it any such small things, and when there is a lull in the wind or anything tends to retard it or sufficiently check its velocity, these objects that were taken up will fall to the earth, and in that locality we will have a "shower" of sticks, stones, frogs, etc., although, strictly speaking, the term "shower" will not be appropriate.

LXXVIII. Wind has not much force until it, by great velocity, becomes much compressed and gains, as it were, solidity.

LXXIX. At times the air is very oppressive, in common phraseology, called "muggy." This occurs when *low* is being developed or we are on the outskirts of an extended condition of *low*. The atmosphere is full of moisture displacing air; in addition to this, the air is quite stationary; there is no new supply, or a very little, coming in from other quarters—the allowance of air is small. As soon as precipitation takes place, or *low* becomes concentrated or moves on we get a bountiful supply of air, which, in contrast, is very refreshing.

LXXX. West winds seem to prevail with us, the cause being that *low* is more off in the ocean than on the land. Water heats quicker, the land retains heat the best. This will account for the constant changes, under some circumstances, such as night breezes and day breezes, as occur along the shores of great bodies of water.

LXXXI. Probably the best place for comfort would be between *high* and *low*; here we get a good breeze; we are, as it were, *in the current*, where the ventilation is generally perfect—occasionally there is too much rapidity for some local comfort, but we must reconcile ourselves with this when we know that it is carrying great comfort to another quarter, restoring balance of air or temperature to our fellow men in some other locality.

LXXXII. In the summer, especially the latter part, we have the wind much from what the Indians practically called the "sweet Southwest." This is occasioned by a moderate low barometer up in the Northeast, perhaps off New Foundland's banks, that region of fogs and mists. Had the Indians known the meteorological facts of the present day they would have had reason to have given this sweet name to the northeast rather than to the southwest—to the quarter that drew the currents on, rather than to a quarter from whence they were collected. The "sweet Southwest," however, at least along the Atlantic coast, is a most refreshing wind, bearing with it the tempered conditions of the West and South

and the effects of land and water; it was indeed beautifully and appropriately named by those sons of nature whom we term Indians. At this season of the year these winds are peculiar, in that they rise with the sun and die away with it, conclusively showing that heat is the cause of the wind. Though the wind dies away with the sun it very soon springs up again, and this may seem to controvert the theory, but instead it only substantiates it. The wind springs up but veers to the south or southeast, according to the trend of the coast, this being caused by the better retention of the heat by the land than by the water. During the day it is on the water, up off the northeast coast. The night cools the water, the land retains the heat, so a current is established landward.

LXXXIII. Later in the season, and indeed, earlier too, *low* is for much of the time still off in the ocean, but in a lower latitude, generating a northwest wind, causing fierce storms in the neighborhood of that storm centre off the coast of Hatteras, lying between there and the Bermuda Islands, in the locality by sailors called the "Devil's Corner." Sailors oftentimes have very expressive names for places and things. This is the locality where concentrated and even protracted *lows* are generated, therefore, a locality of storms; hence the name implying a very bad place—one to be avoided, and one where much caution must be exercised when necessity forces one to pass it. Yet this locality is not always deserving of this name; during the winter and spring months it would seem to be the most appropriate.

LXXXIV. Under Low.—We see that low barometer is continually on the march, from point to point, from the land to the sea and from the sea to the land. After a storm has passed to the eastward the wind comes out more or less fiercely from the west; the sky is cleared of clouds; the wind hangs in this quarter for a a day or two, and, though cool at first, finally dies away, and in summer it comes out very hot and dry. These are probably the most trying days in summer, but this condition is not generally of long duration. *Low* is all the while as it were swimming 'round a circle of larger or smaller dimensions. Narragansett Bay in summer is a fine place to watch these changes. They generally occur about an hour or two after mid-day. At such times it is a common sight to see boats at different points sailing down as well as up the bay *before the wind*, though very little wind, and with a space of perhaps a mile or two between where it is all calm, with a slight flow of wind, first one way then another; the north wind and westerly wind receding and the southerly wind gaining, and by and by coming out a good breeze to the southwest. *Low*, in order to make this change, has the while been shifting, and perhaps the governing one in this case is located up in the northeast, just off the ocean.

The partial wreck of the steamer Massachusetts, while on her eastern trip in Long Island Sound, the early part of November, 1877, is a good illustration of the change of wind in a similar manner, yet more sudden. A heavy southeast storm had prevailed during the day. The captain of the steamer, in order to avoid running the risk of exposing his boat to the fierce winds and waves of the Atlantic ocean, had hugged the Long Island shore. It was very foggy weather,

and so thick, as the sailors say, that no lights were seen from the shore. They were running by dead-reckoning, that is, by their knowledge of the speed of the boat, the force of the currents and general experience of navigation in these waters. As the steamer was, about 11 p. m., near the gate to the ocean, it was decided to turn the head around towards the west, and "stand-by" till morning. From want of exact knowledge of their situation, from not having proper data, the boat was accidentally run ashore on a projecting sand point. Had the wind remained to the Southeast, at the slow rate of speed at which the boat was going, this would not have been a serious matter, but soon after midnight, or thereabout, the wind suddenly came out to the Northwest. The captain now found himself, instead of under a lea, on a lea-shore and at the mercy of a fierce wind. What had caused the change? When we follow up the path of *low*, it is all as plain of explanation as the blowing of the wind itself. On the return of another day, the advancing heat of the sun out on the ocean had caused (or pulled) the center of *low* to the eastward, whereby the wind, that had been blowing toward this center from the northward and westward, was permitted to go into other fields, as it were, in order still to seek the point of *low* that it is all the while striving for. These changes are more or less sudden, depending on the power and concentration of *low* and the relation that it bears to a given locality.

LXXXV. In this connection there are a few other general points of illustration that it may be well to refer to. It is known that there is no regularity to the speed and continuance of *low*; it evidently is continually on the move, yet practically for some localities in the United States it is stationary for some two, three, and sometimes four days, and, on rare occasions, perhaps more; but the most severe spell of such a blow that I bear in mind is that which commenced on the first of March, 1872, and continued with unsurpassed fierceness till the fifth. During this time the conditions were evidently favorable for a concentrated and long *low* off the coast along down and by Hatteras, or, in what sailors call the "Devil's Corner." This was probably one of the most fierce and continuous winds that we have had along the Atlantic coast.

LXXXVI. Sometimes we see all, or nearly all, the evidences of a storm; the clouds form, the wind is in the right direction, and it "feels like rain," but no rain comes perhaps for a month, two months, or even more. Everything is parched for want of rain, and dust is very abundant. This has given rise to the saying "that all signs fail in dry times." It would seem that there could be no fault to find with the "signs;" so far as they are concerned they are all right—they are evidence of conditions actually existing, but the trouble is that these conditions are a long way off. *Low* circles around, but sometimes, more particularly in the summer, it goes very far in some one direction, the circles that it describes are very large while its own circle or center is apt to be contracted, so that it passes by some localities merely touching them with its outer edge, which frequently gives the "sign" as it passes, but nothing more; the rain that is developed, even in part, in the dry localities, is taken off to other places.

LXXXVII. Also on such occasions we see the evening flashes of light, away off in the distant horizon. This, in order possibly to give a name even though the cause was not known, is called "heat-lightning." On the basis of these remarks, and I trust that they are not far out of the way, though we are

still in the dark as to many facts, there does not seem as though there could be any such thing as is implied by this name, but rather that it is a *bona fide* lightning from some center of *low*—perhaps a *local low* or some regular passing centre of *low*, some twenty miles or more away.

LXXXVIII. There is also a common expression in regard to thunder, that "Thunder in the morning, sailors take warning; Thunder at night, sailors delight," as though it were a law that it was worse to have thunder in the morning than in the evening, etc. In the first place it depends upon which direction the thunder proceeds from; if to the East of us it is evident that the storm center or *low* has passed our locality; if to the North that it is passing; if to the South, that it is working its way up towards us; and if to the West, that we may expect it to be or come quite near us. Secondly, there may not be any great "delight" in hearing thunder at night, as in the other case, it all depends on the direction from which it comes, immediately about us, to the North, East, South or West of us. Thunder is more apt to occur in the evening on account of the development of the heat of the day (see section XXXVIII on electricity); where there is thunder in the morning it shows great heat and perhaps the development of a low barometer, and therefore indication of a severe storm. These remarks on thunder and lightning may also, in a general way, apply to the lines "a *rainbow* in the morning," etc. The principle is the same.

LXXXIX. Among other common notions in this department of the weather is the idea that at certain times, mostly morning and evening, when a few heavy broken clouds are massed together and the sunlight is shining through such openings as there may be here and there among them, that the sun is drawing water. This notion evidently grew out of the desire to account for a certain natural phenomena after a supposed reasonable manner; but the knowledge of the present will not sustain any such fanciful idea as this implies. In the first place the sun does not "draw" water, at least in the sense we commonly use this word. It *evaporates* the water and combines it with air, and thereby forms clouds. Secondly, this process is going on all the while, at least when there is sufficient heat. Thirdly, this phenomena called the "sun drawing water," is simply the rays of the sun shining through an opening, and we have the same effect whether the opening be in a cloud or in a wall. The denser the cloud immediately under the sun and the clearer the sky elsewhere, the stronger this effect will be.

In this paper it has been the aim of the writer, as may be readily seen, to bring together all the points in relation to the weather that he could think of, and in order to facilitate memory and to draw special attention to these points so that they would not be lost in the mass, he adopted the plan of numbering each item as it presented itself in as much order as possible, that one point might, as near as possible, suggest the other. He does not claim that he has discovered all, or that all his deductions are right. He has simply endeavored to present the subject from his point of view, and as the same appears to him. And now he stands like others interested in this beautiful study, awaiting further developments. Of course he would like to have future developments sustain what he has here set forth, yet he trusts that he will be enabled to see new facts in an impartial light, and if, perchance, more light should prove him in error as to conclusions, that nevertheless there may be found in this paper some points that may be of interest to those who seek to investigate the mysterious forces that go to make up our weather system. And he further hopes that the interest of the people at large will be general, and of so earnest a nature as to sustain the labors of those who are engaged in the duty of collecting facts pertaining to this branch of science, and extend to them a practical sympathy whereby they may be the better enabled to follow up the great work before them; and further, that this sympathy may so

extend that the nations of the earth may enter into fellowship with each other in collecting facts that bear upon this subject; for only by such cosmopolitan measures can we hope to gain important facts from all quarters of the globe, whereby we may become familiar with the weather system or systems of the world. For this purpose we should have facilities to collect facts, not only from the civilized countries and places easy of access, but from such places as at present are quite inaccessible, either from peculiar conditions of people or climate.

PROGNOSTICATIONS.

After reading these *Statements and Comments* the reader may inquire if there is no way for the individual, unaided by instruments, to forecast the weather. There are certain signs which if one will note from time to time whereby they may become quite expert, but then these personal prognostications must necessarily be confined to the local conditions. The individual from his local standpoint cannot tell what the general conditions are; and herein is where the labors of the signal office particularly become of value, and of greater value than it is possible for the prognostications of the local observer to be, even to his own locality, for the general always governs the local, and knowledge of what is and has been, gives more value to the judgment of the future. A single individual standing on the ground cannot command a very wide horizon, and even on the house-top cannot command anything like the extended region of one who is up in a balloon two or three miles above the earth. The single individual, even aided by instruments, can only know of the conditions of his immediate vicinity; while the Signal Office from its daily reports is able to see the conditions of the whole country; it can note the rate, direction and intensity of the storm center, and from these form a very accurate calculation as to the probability of its passing along a certain line, and in influencing the weather at a particular locality; yet, notwithstanding this, almanac makers and others think they have, or pretend to have, some system different from the natural laws of calculation whereby they can tell what the weather will be a year in advance; and, to make their pretensions more absurd, they make no distinction between different localities, when it is a well-known fact, and now easily demonstrated, that two localities quite near each other may have, and often do have, quite different weather—one being hot while the other is cold, one wet while the other is dry, all depending on the relative situation of *low*.

In the past, before we had the facts of the present, this ridiculous pretension was, perhaps, excusable, for then very little was known of the general weather system—we were all ignorant of the facts that have been ascertained within the past few years. The best that could be done was to judge the weather of one year by that of another, and really the whole matter of attempted prognostication, instead of being a thing of calculation was, and is, really, but a mere matter of guess-work. In these so-called calculations much was figured from the moon, when the moon is a most contemptibly insignificant force in the matter and has about as much to do with the matter as it has with making people mad. Yet, years ago, it was so firmly believed that the moon was the cause of madness that this satellite of the earth gave the name to that unfortunate affliction of humanity. No person now, however, will hold to the absurd idea that lunacy, even though the *name* is connected with the moon, is in any way caused by the moon. As explained elsewhere, the sun is the great physical force that makes our weather system. The better we understand all the forces that go to make up the weather system, make ourselves familiar with all the changes that occur in and constitute the conditions that follow one another, the better weather prophets we will become. We must necessarily keep in mind as much as possible the location of

low, for on this hangs all the information we seek, remembering that the wind will always be *generally* towards the point of low barometer; by bearing this in mind we can approximate the location of *low* in relation to our locality. Then we must note the extent of cloudiness and familiarize ourselves with the different kinds of clouds, bearing in mind that the heavier the clouds and the more extensive the cloudiness the more apt we are to get rain. If the wind is to the east it shows that the centre of *low* is to our west and is approaching our locality, although the centre of the storm may go either to the north or south of us. The presence of low barometer is indicated by a closeness of the atmosphere, commonly called "muggy." If *low* is to the north of us we will have southerly and generally warm winds, while if to the south of us, it will be (relatively) cold (for the season); and, finally, to bear in mind the generally well-known fact that a storm clears off with a west wind and a clear, or quite clear, sky.

These points, noted and studied, will much enhance the correctness of our individual weather prophecies, though the individual can never, for reasons herein explained, rival the prognostications of the Weather Bureau, or foretell the weather for any length of time ahead; and it is doubtful if the Weather Bureau itself can ever foretell the weather for any great length of time in advance, but if it ever does it will only be after years of careful observations whereby it may discover certain changes (if such a thing exists) that take place at regular periods of time, but these changes are so unlimited and can be of such an endless variety it is very much to be doubted if they can ever be discovered to follow a regular course that may be calculated for any great period ahead. Yet, even though such appears to be a hopeless task, it should not hinder our labors in this direction nor cause us to neglect to follow up the good work so zealously begun, for we know not what high reward such earnest labors may meet with, and, even though we cannot discover any tangible law by which this is governed, there is still much left to acquire that will greatly repay us for our sacrifice in this behalf. If there be no similarity between certain periods we will still have gained a great point—we will have proved this as a fact and ascertained how this branch of nature works, for at present we are in the dark in this matter; yet, what facts we have tend to prove that the changes are endless and of infinite variety, and it would seem that the best purposes of nature were obtained from this system, for thereby the grateful showers are the most evenly distributed over the earth.

By the inauguration of the present Weather Bureau more knowledge has been gained in this department in a few years than was ever before known. The work of the past, however, is not to be depreciated, because the present has greater facilities. All enlightened people should be interested in these greater facilities, and, so far as they are able, lend a hand in advancing to them a greater degree of perfection. What we want now is coöperation on the part of the gatherers of scientific information the world over and then a combined and universal weather corps with facilities for extending its simultaneous labors over all important sections of the world, on sea as well as on land. It cannot be expected that so great a work as this would be accomplished in a few months, or even in a number of years, yet steps may be taken towards its accomplishment, and year by year we can advance our stations to new grounds and form combinations and awaken sympathy and zeal on the part of those who at present are ignorant or indifferent as to scientific matters. Only by such extended and united efforts can we fully understand the complete weather system of our planet, and it is to be hoped that the controlling spirits of the world will have sufficient interest and sympathy in the matter to arouse their zeal on behalf of so worthy a cause.

ISAAC P. NOYES.

WASHINGTON, D. C., April, 1878.

THE

WESTERN REVIEW

—OF—

SCIENCE AND INDUSTRY

A Monthly Record of Progress in Science, Mechanic Arts and Agriculture.

Sixty-four pages octavo. $2.50 per annum, post paid. Single Numbers, 25 cents

EDITED BY

THEO. S. CASE,

KANSAS CITY, MO.

This journal has received the warm approval of most of the scientific periodicals of the country, such as *Popular Science Monthly*, *Harper's Weekly*, *New Remedies*, *American Naturalist*, *Science Observer*, &c., &c., also of such prominent scientists as Prof. Spencer F. Baird, Capt. H. W. Howgate, U. S. A., Prof. H. Carrington Bolton, &c., and numbers among its contributors some of the most earnest and capable workers in the West, viz: Prof. G. C. Broadhead, State Geologist of Missouri; Prof. B. F. Mudge, State Geologist of Kansas; W. K. Kedzie, Prof. of Chemistry, State Agricultural College, Kansas; Prof. E. L. Berthoud, of the School of Mines, Colorado; Prof. C. W. Pritchett, of the Morrison Observatory, Glasgow, Mo.; nearly all the members of the Kansas City Academy of Science, and many other well known writers on scientific subjects.

The articles selected for its pages are taken from the very best periodicals of this country and Europe, and are chosen principally with reference to their reliability and their adaptiveness to the popular taste

It being the only journal of the kind in the West, it should receive the patronage and scientific contributions of western men at least, the assurance of the editor being pledged, that as rapidly as the support given him will permit he will enlarge the REVIEW and add to its attractiveness and usefulness by suitable illustrations and in every other manner possible.